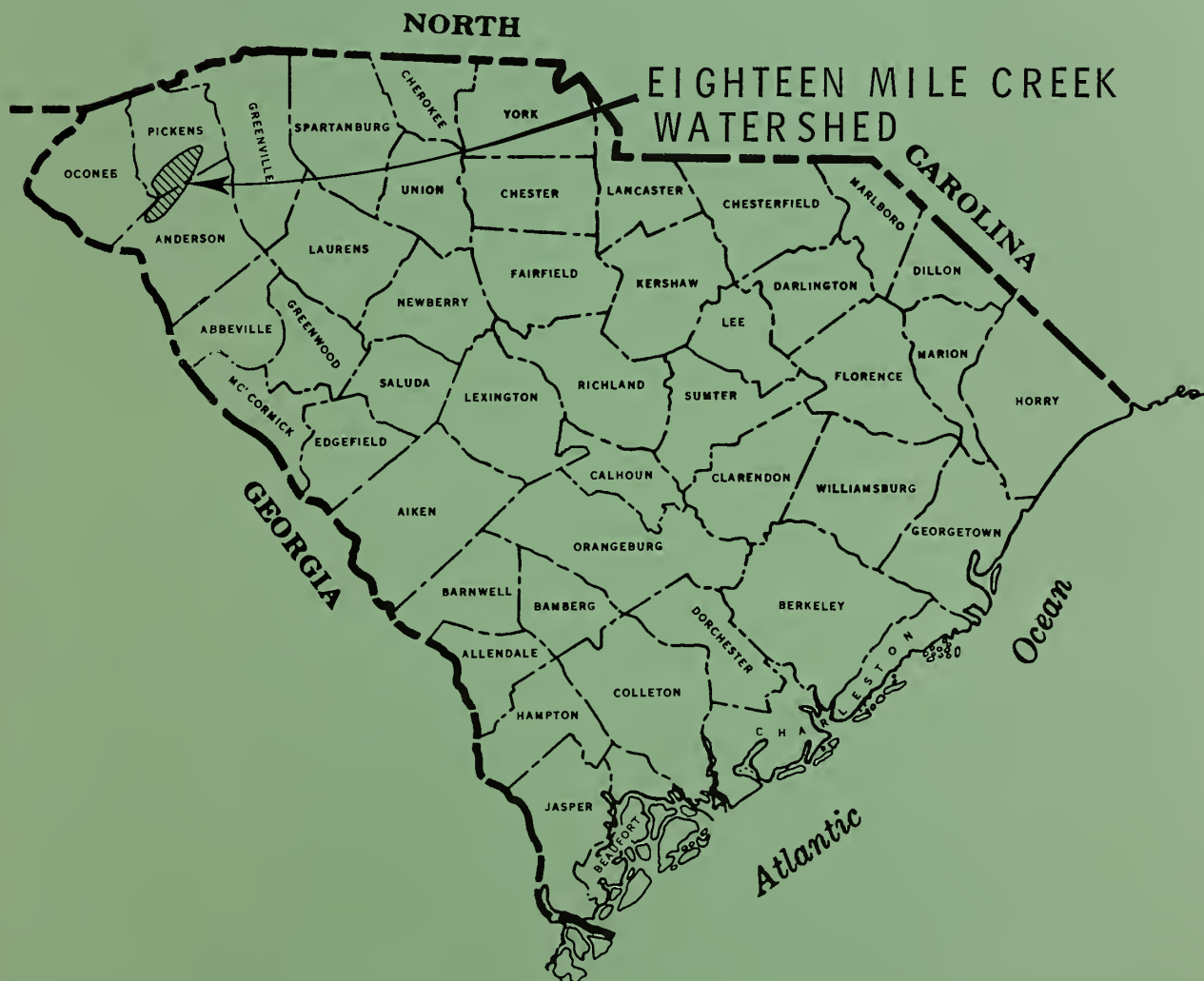


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# PICKENS AND ANDERSON COUNTIES SOUTH CAROLINA



OCTOBER 1971

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WATERSHED WORK PLAN AGREEMENT

between the

Eighteen Mile Creek Watershed Conservation District  
Town of Liberty  
Pickens Soil and Water Conservation District  
Anderson Soil and Water Conservation District

State of South Carolina  
(hereinafter referred to as the Sponsoring Local Organizations)

and the

Soil Conservation Service  
United States Department of Agriculture  
(hereinafter referred to as the Service)

Whereas, application has heretofore been made to the Secretary of Agriculture by the Sponsoring Local Organizations for assistance in preparing a plan for works of improvement for the Eighteen Mile Creek Watershed, South Carolina under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566, 83rd Congress; 68 Stat. 666), as amended; and

Whereas, the responsibility for administration of the Watershed Protection and Flood Prevention Act, as amended, has been assigned by the Secretary of Agriculture to the Service; and

Whereas, there has been developed through the cooperative efforts of the Sponsoring Local Organizations and the Service a mutually satisfactory plan for works of improvement for the Eighteen Mile Creek Watershed, State of South Carolina, hereinafter referred to as the watershed work plan, which plan is annexed to and made a part of this agreement;

Now, therefore, in view of the foregoing considerations, the Sponsoring Local Organizations and the Secretary of Agriculture, through the Service, hereby agree on the watershed work plan, and further agree that the works of improvement as set forth in said plan can be installed in about five years.

It is mutually agreed that in installing and operating and maintaining the works of improvement substantially in accordance with the terms, conditions, and stipulations provided for in the watershed work plan:



1. The Sponsoring Local Organizations will acquire without cost to the federal government such land rights as will be needed in connection with the works of improvement. (Estimated cost \$244,300.)
2. The Eighteen Mile Creek Watershed Conservation District will provide relocation advisory assistance services and make the relocation payments to displaced persons as required by the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, 84 Stat. 1894), effective as of January 2, 1971, and the Regulations issued by the Secretary of Agriculture pursuant thereto. Prior to July 1, 1972, the Eighteen Mile Creek Watershed Conservation District will comply with the real property acquisition policies contained in said Act and Regulations to the extent that it is legally able to do so in accordance with state law. After July 1, 1972, the real property acquisition policies contained in said Act shall be followed in all cases.

The Service will bear 100 percent of the first \$25,000 of relocation payment costs for any persons, business, or farm operation displaced prior to July 1, 1972. Any such costs for a single dislocation in excess of \$25,000 and all costs for relocation payments for persons displaced after July 1, 1972, will be shared by the Eighteen Mile Creek Watershed Conservation District and the Service as follows:

	<u>Eighteen Mile Creek Watershed Conservation District</u> (percent)	<u>Service</u> (percent)	<u>Estimated Relocation Payment Costs</u> (dollars)
Relocation Payments	41.3	58.7	800

3. The Sponsoring Local Organizations will acquire or provide assurance that landowners or water users have acquired such water rights pursuant to state law as may be needed in the installation and operation of the works of improvement.

4. The percentages of construction costs of structural measures to be paid by the Sponsoring Local Organizations and by the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations (percent)</u>	<u>Service (percent)</u>	<u>Estimated Construction Cost (dollars)</u>
Multiple Purpose Structure 4			
Joint Costs:	21.5	78.5	310,800
Specific Costs:			
Grubbing 55 acres in the reservoir	100	0	5,500
Two Floodwater Retarding Structures and 9,850 linear feet of channel improvement	0	100	317,100

5. The percentages of the engineering costs to be borne by the Sponsoring Local Organizations and the Service are as follows:

<u>Works of Improvement</u>	<u>Sponsoring Local Organizations (percent)</u>	<u>Service (percent)</u>	<u>Estimated Engineering Costs (dollars)</u>
Multiple Purpose Structure 4			
Joint Costs:	21.5	78.5	27,000
Two Floodwater Retarding Structures and 9,850 linear feet of channel improvement	0	100	29,000

6. The Sponsoring Local Organizations and the Service will each bear the costs of project administration which it incurs, estimated to be \$11,000 and \$97,900, respectively.
7. The Sponsoring Local Organizations will obtain agreements from owners of not less than 50 percent of the land above each reservoir and floodwater retarding structure that they will carry out conservation farm or ranch plans on their land.
8. The Sponsoring Local Organizations will provide assistance to landowners and operators to assure the installation of the land treatment measures shown in the watershed work plan.
9. Cost sharing for critical area stabilization is agreed to by increments of work as follows:

<u>Treatment</u>	<u>PL-566</u>	<u>Other</u>
285 acres of grasses and legumes	Furnish seed, plants, lime, mulch, fertilizer, and fencing materials. Bear the cost of plant- ing seed or plants and applying lime and fertilizer.	Prepare the sites and construct or relocate fences where necessary.
365 acres of trees	Prepare the site and bear the cost of tree planting.	Provide trees, mulch material, and construct or relocate fences where needed to protect the seedlings.

10. The Sponsoring Local Organizations will encourage landowners and operators to operate and maintain the land treatment measures for the protection and improvement of the watershed.
11. The Sponsoring Local Organizations will be responsible for the operation and maintenance of the structural works of improvement by actually performing the work or arranging for such work in accordance with agreements to be entered into prior to issuing invitations to bid for construction work.



12. The costs shown in this agreement represent preliminary estimates. In finally determining the costs to be borne by the parties hereto, the actual costs incurred in the installation of works of improvement will be used.
13. This agreement is not a fund obligating document. Financial and other assistance to be furnished by the Service in carrying out the watershed work plan is contingent on the appropriation of funds for this purpose.

A separate agreement will be entered into between the Service and the Sponsoring Local Organizations before either party initiates work involving funds of the other party. Such agreement will set forth in detail the financial and working arrangements and other conditions that are applicable to the specific works of improvement.

14. The watershed work plan may be amended or revised, and this agreement may be modified or terminated, only by mutual agreement of the parties hereto.
15. No member of or delegate to Congress, or resident commissioner, shall be admitted to any share or part of this agreement, or to any benefit that may arise therefrom; but this provision shall not be construed to extend to this agreement if made with a corporation for its general benefit.
16. The program conducted will be in compliance with all requirements respecting nondiscrimination as contained in the Civil Rights Act of 1964 and the Regulations of the Secretary of Agriculture (7 C.F.R. Sec. 15.1-15.12), which provide that no person in the United States shall, on the ground of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.

EIGHTEEN MILE CREEK WATERSHED CONSERVATION DISTRICT

By \_\_\_\_\_

Title \_\_\_\_\_

Address \_\_\_\_\_

Zip Code

Date \_\_\_\_\_

The signing of this agreement was authorized by a resolution of the governing body of the Eighteen Mile Creek Watershed Conservation District adopted at a meeting held on \_\_\_\_\_.

\_\_\_\_\_  
(Secretary, Eighteen Mile Creek Watershed Conservation District)

Date \_\_\_\_\_

TOWN OF LIBERTY

By \_\_\_\_\_

Title \_\_\_\_\_

Address \_\_\_\_\_

Zip Code

Date \_\_\_\_\_

The signing of this agreement was authorized by a resolution of the governing body of the Town of Liberty adopted at a meeting held on \_\_\_\_\_.

\_\_\_\_\_  
(Secretary, Town of Liberty)

Date \_\_\_\_\_

PICKENS SOIL AND WATER CONSERVATION DISTRICT

By \_\_\_\_\_

Title \_\_\_\_\_

Address \_\_\_\_\_

Zip Code \_\_\_\_\_

Date \_\_\_\_\_

The signing of this agreement was authorized by a resolution of the governing body of the Pickens Soil and Water Conservation District adopted at a meeting held on \_\_\_\_\_.

\_\_\_\_\_  
(Secretary, Pickens Soil and Water Conservation District)

Date \_\_\_\_\_

ANDERSON SOIL AND WATER CONSERVATION DISTRICT

By \_\_\_\_\_

Title \_\_\_\_\_

Address \_\_\_\_\_

Zip Code \_\_\_\_\_

Date \_\_\_\_\_

The signing of this agreement was authorized by a resolution of the governing body of the Anderson Soil and Water Conservation District adopted at a meeting held on \_\_\_\_\_.

\_\_\_\_\_  
(Secretary, Anderson Soil and Water Conservation District)

Date \_\_\_\_\_

SOIL CONSERVATION SERVICE  
UNITED STATES DEPARTMENT OF AGRICULTURE

By \_\_\_\_\_  
Administrator

Date \_\_\_\_\_

WATERSHED WORK PLAN  
EIGHTEEN MILE CREEK WATERSHED  
Pickens and Anderson Counties  
South Carolina

Prepared under the Authority of the Watershed  
Protection and Flood Prevention Act (Public  
Law 566, 83rd Congress, 68 Stat. 666), as amended

Prepared by: Eighteen Mile Creek Watershed Conservation District  
Town of Liberty  
Pickens Soil and Water Conservation District  
Anderson Soil and Water Conservation District

With Assistance by:

U.S. Department of Agriculture, Soil Conservation Service  
U.S. Department of Agriculture, Forest Service

OCTOBER 1971





THE WATERSHED WORK PLAN  
Eighteen Mile Creek Watershed  
Pickens and Anderson Counties  
South Carolina

SUMMARY OF PLAN

This document is a plan for watershed protection, flood prevention, and municipal water storage in the Eighteen Mile Creek Watershed located within Pickens and Anderson Counties, South Carolina. The plan covers 35,600 acres and was developed by the Sponsoring Local Organizations with assistance from the Soil Conservation Service and the Forest Service, United States Department of Agriculture. The sponsors are:

Eighteen Mile Creek Watershed Conservation District  
Town of Liberty  
Pickens Soil and Water Conservation District  
Anderson Soil and Water Conservation District

This project is one of 42 upstream watersheds recommended in the recently published Plan for Development of Water Resources in Appalachia for "early action and implementation".

The primary problem in the watershed is an estimated \$79,000 average annual flood damage from overbank flow. These losses occur in the form of floodwater and sediment damage to: (1) crops and pastures on more than 600 acres of fertile bottomland; (2) residential properties in the vicinity of the towns of Clemson and Pendleton; (3) experimental projects of Clemson University; and (4) other fixed improvements such as roads, bridges, farm buildings, fences, etc.

Other problems include a need for additional municipal water storage for the town of Liberty and fish and wildlife habitat development and management.

The works of improvement proposed by this Work Plan are designed and planned to reduce or solve these problems in a manner contingent with the sponsors' objectives and watershed planning criteria as set forth by Public Law 566. The project measures to be installed during a five year period include: (1) application of conservation measures on about 7,000 acres; (2) stabilization of 650 acres of critically eroding uplands by appropriate land treatment; (3) establishing and managing 400 acres of the upland for wildlife food and cover; (4) construction of two floodwater retarding structures and one multiple purpose structure containing 800 acre feet of municipal water storage; and (5) improvement of about 9,850 linear feet of stream channels.

The estimated installation costs of project measures are:

	Installation Cost (Dollars)		
	PL-566 Cost	Other Cost	Total Cost
(1) Land Treatment	175,400	290,000	465,400
(2) Floodwater Retarding Structures 2 and 3	274,700	124,100	398,800
(3) Multiple Purpose Structure 4	265,200	171,600	436,800
(4) Stream Channel Improvement	71,900	27,000	98,900
(5) Project Administration	97,900	11,000	108,900
TOTAL COST	885,100	623,700	1,508,900

Average annual benefits to be derived from installation of structural measures are:

Flood Damage Reduction	
Floodwater	\$ 43,900
Sediment	4,600
Indirect	5,500
More Intensive Land Use	21,500
Municipal Water Storage	8,000
Incidental Benefits	
(Recreation and Enhance- ment of Land Values)	19,900
Local Secondary	13,700
Redevelopment	8,100
TOTAL	\$125,200

The average annual cost of structural measures is \$58,400. Thus, the derived benefit-cost ratio is 2.1 to 1.

The Eighteen Mile Creek Watershed Conservation District will use its authority to insure the installation of and proper operation and maintenance of the structural measures. The town of Liberty will assist in the operation and maintenance of multiple purpose Structure 4 and Clemson University will assist the District in maintaining the channel improvement. The estimated annual cost of operation and maintenance of all structural measures is \$2,000.

## DESCRIPTION OF THE WATERSHED

### Physical Data

Eighteen Mile Creek Watershed covers about 35,600 acres in north-western South Carolina. It extends 20 miles from Easley, on the north-eastern rim, to Hartwell Reservoir southwest of Pendleton. The watershed area is elongated in shape with the average width about three miles. It includes 28,200 acres in southern Pickens County and 7,400 in Anderson County. The watershed is bordered by the Three and Twenty Creek Watershed on the south and Twelve Mile Creek Watershed on the north.

Eighteen Mile Creek and its major tributary, Fifteen Mile Creek, are a part of the Savannah River Basin. Elevations vary from about 1,300 feet above sea level on Mauldin Mountain to 665 feet at the outlet. Drainage is to the southwest.

The residential and industrial water needs of Liberty are met through the town's municipally owned system. This system is supplied by Eighteen Mile Creek with intake facilities located near U.S. Highway 178. Most of the water for rural residents is supplied by wells. Numerous small lakes provide water for livestock and partially satisfy recreational needs.

The drainage area of the watershed conforms to the Pendleton syncline. The major rock types are biotite, hornblende, and granite gneiss. Cecil, Madison, Hiwassee and Pacolet are the main upland soils. The soils of the bottoms belong to the Toccoa-Chewacla association.

Soil cover within the watershed is fair to good. Upland erosion is not severe except for the small scattered critical areas. The hydrologic condition of the land is generally poor as a result of improper management.

Present land use is as follows:

<u>Land Use</u>	<u>Acres</u>	<u>Percent</u>
Cultivated	1,700	5
Pasture and Idle	5,200	15
Woods	21,300	60
Miscellaneous	<u>7,400</u>	<u>20</u>
TOTAL	35,600	100



The watershed is located in the northwest climatic division of South Carolina. The average annual precipitation is 49 inches. The average seasonal distribution of precipitation is 25 percent in the spring, 26 percent in the summer, 21 percent in the fall and 28 percent in the winter. The average annual temperature is 61 degrees Fahrenheit.

#### Economic Data

The population of the watershed is about 9,000 urban and 7,000 rural. Recent trends have shown a decline in rural residents, but a moderate increase in the suburban population. The towns of Easley, Liberty, Central, Clemson, Norris and Pendleton are located partially within the watershed boundary.

Income within the area is mainly derived from textile manufacturing and agriculture. In the lower portion of the watershed, the economy depends heavily upon employment by Clemson University. Principal farming enterprises are livestock, forest products, grains, soybeans and poultry.

The estimated 175 farms in the watershed average about 160 acres in size and \$35,000 in value. Most of these are low income family farms and about 80 percent have annual sales of less than \$2,500. Very few farming operations employ full time labor. A small amount of seasonal and custom labor is utilized.

There is no Federally owned land in the watershed. Clemson University owns about 3,700 acres, including extensive research facilities, in the lower portion. The remainder is in private ownership, except small tracts owned by local governments.

The average value of the upland in the watershed is \$325 per acre. Flood plain values range from \$75 per acre in swamped areas to \$500 where flooding is not severe, except in the area below Pendleton where research projects are carried on by Clemson University. There is no known recent appraisal of this experimental land, but values are several times greater than similar bottomland in the area.

An excellent network of roads links the watershed with markets in Anderson, Greenville and Spartanburg. In addition to a well developed system of improved secondary roads, State Highways 28, 93, 88 and 135 and U.S. Highways 76, 178, and 123 connect the watershed area with the rapidly expanding "industrial corridor" of South Carolina. Interstate Highway 85 parallels the watershed about eight miles to the southeast. The Southern and Blue Ridge Railroads serve the area.

The Appalachian Regional Development Act of 1965 designated this area as one of chronic underemployment and unemployment. There is a great potential for community development through proper land use and



treatment, flood protection, and increased water supply. The Plan for Development of Water Resources in Appalachia lists this watershed project as a key element in fostering economic growth of this part of South Carolina.

The 20,300 acres of forests in upland types are 95 percent of the total woodlands. Upland forest types are pine, 68 percent; pine-hardwoods, 8 percent; and hardwood, 24 percent. The principal species of the upland are shortleaf pine, Virginia pine, red cedar, red oaks, white oaks, yellow poplar, sycamore, sweetgum, hickory, and dogwood. Other species are planted loblolly pine, elm, maple, miscellaneous oaks, sourwood, persimmon, black cherry, and associated species.

Woods in the flood plain constitute 1,000 acres, or about five percent of the total forest lands. Principal species in the flood plain are red maple, yellow poplar, ash, sycamore, red gum, cottonwood, black gum, water oak, willow oak, and other bottomland species. The total stocking on the area is about 100 percent well stocked, and 92 percent stocked with good merchantable species.

The South Carolina State Commission of Forestry, in cooperation with the U.S. Forest Service, through the various Federal-State cooperative forestry programs, is providing forest management assistance, forest fire protection and suppression, distribution of planting stock and forest pest control assistance to private landowners in the watershed.

There is no area owned by the U.S. Forest Service. There are 3,000 acres of woodland owned by Clemson University. The bulk of the forest land is in small, private ownership, with less than one percent in industrial holdings. Given protection and proper management, the forest stands will contribute considerably to the future overall economy of the watershed area.

#### Land Treatment Data

The project area is served by the Soil Conservation Service Work Unit Offices in Pickens and Anderson, South Carolina. These offices assist the Pickens and Anderson Soil and Water Conservation Districts (S&WCD) and the Eighteen Mile Creek Watershed Conservation District.

The two S&WCDs have assisted 160 landowners in the watershed with soil and water conservation plans. These plans cover 14,000 acres or about 40 percent of the drainage area of Eighteen Mile Creek. It is estimated that 40 percent of the needed land treatment in the watershed has been applied. These applied practices have been valued at \$555,000. (See Table 1A.)

Most of the critically eroding areas are gullies, unimproved roads,

unprotected road banks, and steep cultivated fields. These areas are generally small, but are located throughout the watershed.

Most of the soils in the cultivated areas are Capability Classes IIe, IIIe, and IVe. Land use trends indicate that a portion of the upland now in row crops will be changed to grassland, woodland, or urban development. Much of the fertile flood plain affected by frequent and severe flooding will be restored to high producing crops, pasture, woodland and land for research activities. The primary purpose of project measures is not to bring new land into production. Most of the flood plain soils are Capability Classes IIw, IIIw, and IVw.

#### Fish and Wildlife Resource Data

Fish and wildlife resources in the watershed are moderate to low. Wildlife resources consist primarily of small game species. The streams are shallow and constitute low-quality fish habitat.

### WATERSHED PROBLEMS

#### Floodwater Damage

Nearly 2,000 acres of flood plain along Eighteen Mile Creek and its tributaries are flooded annually. Some areas, particularly in the lower portion of the watershed, flood as often as five times per year. More than one-third of the floods occur during the growing season.

A large portion of the flood plain, once used for high producing crops and pastures has reverted to less intensive use and abandoned areas. Flood damage to existing crops and pastures has caused increased production and maintenance costs, hampered good management practices, and prevented intensive use of most of the flood plain. These damages amount to \$12,500 annually. Damages to other agricultural property, including fences and other fixed improvements, farm roads and bridges, livestock losses, increased production costs, and damages to Clemson University research activities are estimated to total \$42,200 annually.

Nonagricultural damages in the form of scoured road surfaces, erosion of bridge abutments, bridge and culvert wash-outs, and damages to residences and other permanent improvements total \$11,500 per year. Floodwater and sediment damage yards and fixed improvements surrounding several homes in the vicinity of Highway 28. According to survey data, the 100-year storm will not reach the first floor level of any residence now in the flood plain.

In addition, frequent flooding is a serious danger to the health and lives of people in the community.





**FLOOD PLAIN SCOUR AND SEDIMENT DAMAGE IN CLEMSON UNIVERSITY BOTTOMLAND  
CAUSED BY FLOODING OF EIGHTEEN MILE CREEK**



**PASTURES ARE DAMAGED SEVERELY BY SEDIMENT DEPOSITS OF ERODED SOIL  
FROM UNPROTECTED UPSTREAM LAND TRANSPORTED BY FLOODWATER**

### Sediment Damages

Sediment damages include overbank deposition; clogging of channels, outlet ditches, and tile drains; swamping; sediment deposits in Hartwell Reservoir; and damage to municipal and industrial water intake systems. Present damages generally are not as severe as in past years due to the installation of conservation measures and land use changes.

Approximately 400 acres are presently being damaged in varying degrees by overbank deposition of sediment. These deposits not only damage the land, but reduce crop yields, and limit livestock grazing. More than 100 acres are swamped as a result of sediment deposits along streambanks.

Previous deposition in streams and ditches has caused higher water tables, more frequent flooding, and the destruction of fish habitat. Shifting of bedload sediment has clogged tile drain outlets at the Clemson University experimental farm. As a result, sump pumps and other measures to remove floodwaters and provide surface drainage have been installed.

An estimated 48,200 tons of sediment from the Eighteen Mile Creek Watershed is being delivered annually to Hartwell Reservoir.

The present estimated suspended sediment concentration at the Liberty water intake is 815 parts per million and 285 parts per million near the mouth of the watershed. Approximately 86 percent of this sediment is in the suspended state.

The average annual sediment damage evaluated amounts to \$6,700.

### Erosion Damages

Other than numerous, generally small critical areas, the watershed erosion problems are minor. No monetary evaluation was made of erosion damages. There are only a few upland cultivated fields with a high erosion rate. The accumulated total of the small critical areas is estimated to be 660 acres.

The accumulated effect of all critical areas is significant on downstream areas receiving sediment damage.

### Problems Relating to Water Management

Drainage is not considered a problem. Most of the existing channels are adequate outlets for on-farm drainage.

The town of Liberty presently has a low head dam on Eighteen Mile Creek and depends upon stream flow for their water supply. They have



a contract with the city of Easley for supplemental supply as needed when the stream flow is inadequate. Current use is about 1.6 MGD and within 25 years, expected use will be 4.0 MGD. The population and industrial growth of the town of Liberty has created a need for additional municipal and industrial water. After considering other sources of water, the town of Liberty concluded that the most feasible supply to meet their needs could be provided by an impoundment on Eighteen Mile Creek.

The Eighteen Mile Creek classification by the South Carolina Pollution Control Authority is "Class B", which is satisfactory for the intended uses. Oxidation pond effluent from the city of Easley which enters Eighteen Mile Creek above Site 4 is well treated. Wastes from the town of Liberty and Woodside Mill at Liberty which enter the stream between Sites 3 and 4 are effectively treated. Sources of wastes entering Fifteen Mile Creek above Site 2 are near Norris and very small in quantity. Other wastes entering the stream are below the proposed impoundments. The South Carolina Pollution Control Authority will enforce adequate treatment of all effluents to assure that proper quality is maintained.

The watershed stream fishery is not of significant value. Small game is found throughout the watershed.

#### PROJECTS OF OTHER AGENCIES

There are no known projects which will adversely affect the works of improvement proposed in this plan.

The Hartwell Reservoir, a multiple purpose lake developed by the Corps of Engineers, is located at the lower boundary of the watershed. The planned works of improvement will reduce the amount of sediment now being delivered to the reservoir from this tributary.

#### PROJECT FORMULATION

This project is formulated to provide a solution to the floodwater, sedimentation, and erosion problems of the watershed, to provide water storage for municipal use by the town of Liberty, South Carolina, and to protect and enhance the fish and wildlife resources of the area.

In order to accomplish these goals, the Service and the sponsors have agreed upon the following objectives to be met during the installation period: (1) adequate land treatment measures on 600 acres of the cropland, 2,000 acres of grassland, and 4,120 acres of the woodland, (2) desired land use adjustment, (3) approximately 650 acres of critical sediment source areas be treated, (4) a system of floodwater



retarding structures and channel improvement be installed that will reduce average annual flood damages to agricultural enterprises by at least 60 percent, (5) approximately 800 acre feet of water be stored for the town of Liberty, and (6) 400 acres of the upland be specifically developed for wildlife habitat. Other land treatment measures, reforestation, and construction of three reservoirs will improve fish and wildlife habitat.

Full recognition has been given to all agricultural and non-agricultural needs and trends. Consideration was given to areas of intensive use, present and future. As a general rule, the greatest flood protection is planned for these areas. However, limitations caused by the extensive network of roads, home sites, and other fixed improvements has limited the selection of structural sites.

Additional structure sites were considered on two tributaries to Eighteen Mile Creek upstream from U.S. Highway 123 in the vicinity of Central and in the headwaters of Fifteen Mile Creek in the vicinity of Road 270. In each case, it was found that the controlled drainage area was relatively small and the reduction in downstream flooding would not justify their construction.

Several principal spillway alternates were studied at each structure to determine the size and type of the proposed principal spillway. The capacity of the channel downstream from the structure, drawdown requirements, economics, and reservoir limitations were the principal factors considered. In each case the lowest discharge rate allowable was selected.

Channel improvement was considered in several areas of the watershed, but because of induced damage to fixed improvements, restrictive design criteria, a lack of benefits, or in the interest of protecting fish and wildlife habitat, only that portion of channel below U.S. Highway 76 is considered feasible. Without this section of channel improvement through the area of most intensive flood plain use, the project objectives could not be met.

The Appalachian Water Resource Survey, August 1967, identified a need for additional water based recreational facilities within the watershed. The Sponsoring Local Organizations have considered this need in formulating the project objectives and works of improvement to be installed. However, due to a lack of funds on the part of the sponsors of the watershed project and unavailability of any other organization or group willing to meet the local responsibilities for such a recreational development, none has been included in this plan.

The land treatment needs were developed from a field survey of the watershed. The measures to be applied are those conservation practices that will be installed during the installation period. Technical

assistance requirements include only the accelerated needs above the going programs.

The allowable annual soil loss for cropland in the watershed is three to four tons per acre.

The proposed works of improvement will not materially increase the fire hazard or risk. The State goal for the annual fire loss index is 0.25, while the present watershed protection goal is 0.20. The average annual fire loss index in the watershed for the period 1960 through 1969 was 0.25 percent. This is slightly higher than the desired goal.

#### WORKS OF IMPROVEMENT TO BE INSTALLED

##### Land Treatment Measures

The Pickens and Anderson Soil and Water Conservation Districts have been assisting landowners of the watershed for a number of years. The conservation programs offered by the Districts are based on the wise use, necessary treatment, and proper management of the soil, water, and wildlife resources within the area.

Accelerated application and continued maintenance of land treatment measures are necessary. Without adequate land treatment and management the structural works of improvement cannot be installed. For this reason, in addition to the presently available technical assistance, \$108,500 will be made available from Public Law 566 funds to accelerate the installation of conservation practices.

About 600 acres of cropland will be treated with a combination of measures. These include conservation cropping systems, grassed waterways and outlets, ponds, open and tile drains, terraces, field border plantings, access roads, and other practices. These measures will provide better control of rainfall runoff, allow a greater quantity of water to enter the soil, and thereby reduce rates of sheet and gully erosion.

Land treatment measures on about 2,000 acres of grassland will consist of pasture and hayland planting and management, ponds, drainage mains and laterals, and proper grazing use.

Recreation area improvement and access roads will be established on about 75 acres. About 400 acres will be developed and managed as wildlife habitat.

Land treatment measures will be applied on about 4,120 acres of forest land. These measures include conversion, site preparation, tree planting, releasing, and improved cutting.



Appropriate vegetative cover will be used to treat 650 acres of critically eroding areas within the watershed. There are about 365 acres of open, critically eroding lands to be stabilized by planting trees. Loblolly pine will be the primary species used. Approximately 285 acres will be treated with grasses and legumes.

The South Carolina State Commission of Forestry will accelerate the going Cooperative Forest Fire Control Program in the watershed area. One light suppression unit will be added in 1969-70 with State funds.

### Structural Measures

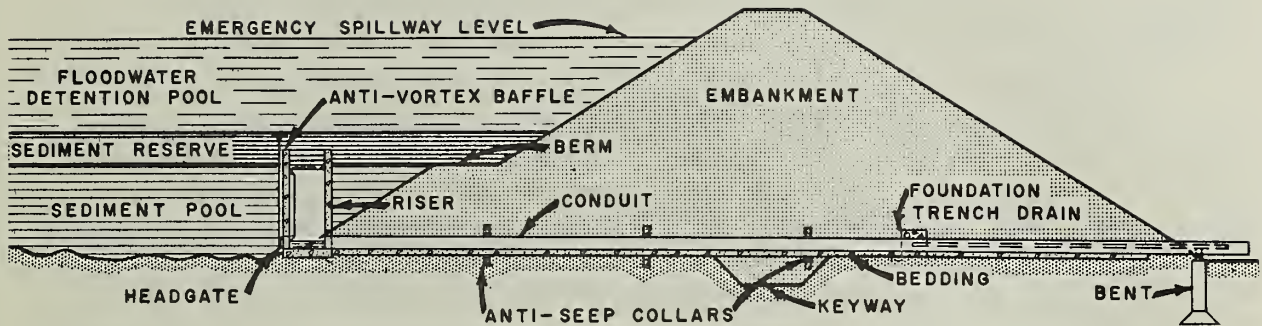
Structural measures consist of two single purpose structures for flood prevention, one multiple purpose structure for flood prevention and the storage of municipal water, and approximately one and nine-tenths miles of stream channel improvement for flood prevention. All planned structural measures will meet the requirements of local and state health laws. The planned location of structural measures is shown on the Project Map on Page 45. Design data are shown in Tables 3 and 3A.

The total drainage area above structures is 17,200 acres, or about one-half of the watershed area.

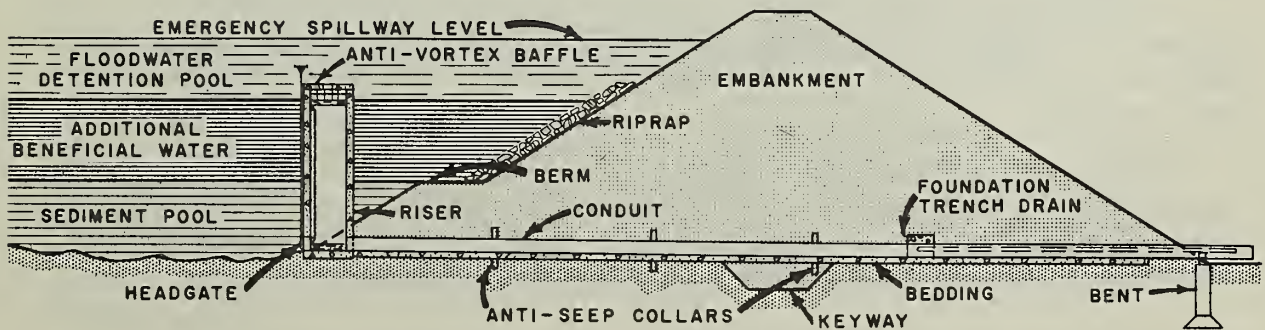
Structure 4 will store 800 acre feet of municipal water for the town of Liberty. The town plans to grub 55 acres in the reservoir to improve initial water quality. The grubbing procedure will reduce the organic matter initially in the reservoir and will minimize possible manganese problems. The municipal water will be removed from the reservoir through a new pumping station to be located at the reservoir. A new pipeline will connect the new pumping station to the existing water filter plant. The existing pumping station, sheet pile dam, and pipeline to the water filter plant will be abandoned or removed. The new pumping station and pipeline and the abandonment or removal of the existing pumping station, sheet pile dam, and pipeline to the water filter plant are not part of the project measures.

All three structures will consist of earthfill embankments on yielding foundations, reinforced concrete principal spillways, and vegetated emergency spillways. Each principal spillway will have a reinforced concrete inlet, reinforced concrete pipe with anti-seep collars, and will outlet into an excavated plunge basin. The emergency spillways for Structures 3 and 4 will have a one percent chance of operation in any year. The emergency spillway of Structure 2 will have a two percent chance of operation in any year.

All structures are designed for an effective life of 100 years. The crest elevation of the principal spillways for Structures 2 and 3 will be the 50 year sediment accumulation elevation. The crest elevation of the principal spillway of Structure 4, which has a 100 year sediment



**SECTION OF A TYPICAL  
FLOODWATER RETARDING STRUCTURE**  
(WITH SINGLE STAGE RISER)



**SECTION OF A TYPICAL  
MULTIPLE PURPOSE STRUCTURE**  
(WITH SINGLE STAGE RISER)



pool, will be the maximum elevation of the municipal water pool. The upstream face of Structure 4 will be riprapped in the area subject to drawdown and wave action.

A substantial amount of borrow material will be obtained from the excavated emergency spillways. Other borrow areas are available near the proposed structures. The volume of borrow available in the emergency spillway of Structure 3 exceeds the volume necessary to build the structure. This extra material will be wasted or may be used in raising S.C. Highway 27 located upstream from the structure. Suitable vegetation will be established on the embankments, emergency spillways, and exposed borrow areas.

Two county roads located in the flood pool of Structure 4 will require raising and one bridge will be replaced. S.C. Highway 27, upstream from Structure 3 and the bridge at that location will require raising. A telephone cable and a six-inch water main crossing at the same location will require minor alterations. A tower on Duke Power Company's North Greenville-Central 230 KV transmission line upstream from Structure 3 will be raised. The company is considering the reservoir in their design on the Oconee-Newport 500 KV transmission line presently being planned. S.C. Highway 395, upstream from Structure 2 will require raising and the bridge at that location will be raised and lengthened. An old barn upstream from the S.C. Highway 395 bridge is in the flood pool and will be moved. The structures will not require any other changes to fixed improvements other than moving farm fences presently located in the proposed reservoir areas.

An asbestos shingled frame dwelling located east of the S.C. Highway 27 bridge is below the top of dam elevation of Structure 3. The two adult residents will be the only persons or businesses relocated in this project.

Channel improvement consists of approximately 1.9 miles of channel enlargement on the lower end of Eighteen Mile Creek on the property of Clemson University. The upstream end of the channel improvement will be immediately downstream from the U.S. Highway 76 bridge.

The channel improvement is designed to provide protection from the two-year frequency, 24 hour duration storm. The width and depth of channels were selected to provide the desired flood protection. The design grade and depth of channels are approximately the same as the existing depth and grade, except in the lower reach where the channel is steeper than the existing grade. The design discharge shown in Table 3A is the discharge which the channel will contain before damage begins.

The improved channel will generally follow the same course as the existing channel. Where necessary, side drainage will enter the channel by side inlet pipes or ditches. Rock fords or culverts may be necessary



to provide access for maintenance.

The upper reach of channel, from U.S. Highway 76 to the lower end of the field below S.C. Highway 279 (Station 805+00), will be excavated from one side leaving one bank in its stable condition. The spoil in this area will be shaped to facilitate maintenance and may be spread over the adjacent fields by Clemson University.

The existing dike on the left side of the channel between S.C. Highway 279 and Station 805+00 will remain undisturbed.

From Station 805+00 to the downstream end of channel improvement, the channel will be excavated from both sides and shaped to facilitate maintenance.

Travelways will be constructed on the spread spoil on both sides of the creek from Station 805+00 to the downstream end of channel improvement. The open fields in the upper reach will provide adequate access for maintenance.

Three temporary rock riprap chutes are planned to control the grade and degradation of the channel upstream from Station 825+00 while vegetation is being established. The rock structures, planned for an effective life of two or three years, will be used to permit establishment of vegetative measures and permit the resultant change in "n" values and velocities.

The bridge over S.C. Highway 279 will be lengthened to conform with the increased width of the channel. No other changes to fixed improvements are required in the area where channel improvement is planned, except for moving farm fences adjacent to the channel.

Channel construction work will be scheduled for completion at a time of year that will provide a full growing season immediately following construction. The soil, site, moisture, climate, and fertility relationship in this watershed is very favorable for quick vegetative growth. Experience in previously constructed channels has shown that natural vegetation will rapidly cover channel banks normally in one growing season.

An inspection will be made of the channel improvement work after the first full growing season to determine the adequacy of native vegetative cover. Bare areas found to be contributing appreciable amounts of sediment will be stabilized with suitable vegetation or other measures as a project cost. Based upon a recent study of previously improved channels in similar watersheds in the Piedmont area of South Carolina, all planned channel improvement will be stable with a minimum amount of erosion.

## EXPLANATION OF INSTALLATION COSTS

### Land Treatment

Land treatment measures to be applied during the project installation period are estimated to cost \$465,400. Of this total, \$174,400 will be paid by PL-566 funds and \$290,000 will be provided from other funds.

In order to meet the goals of adequate land treatment, PL-566 funds will provide \$75,700 for accelerated technical assistance by the Soil Conservation Service and \$32,800 by the U.S. Forest Service. In addition, PL-566 funds will provide \$46,500 for cost sharing for critical area plantings by the Soil Conservation Service and \$20,400 for tree planting on critical areas by the U.S. Forest Service.

Other funds include \$17,000 for technical assistance provided under the going program of the Soil Conservation Service and \$5,000 from the South Carolina State Commission of Forestry for accelerated technical assistance. The going Cooperative Forest Management Program will provide additional technical assistance valued at \$2,700. The State Commission of Forestry will provide a capital outlay of \$4,300 to improve the going Cooperative Forest Fire Control Program.

The remainder of other funds will be borne by individual landowners and operators, utilizing the cost sharing assistance available through the Rural Environmental Assistance Program. These costs include material, labor, and machinery necessary for the installation of land treatment measures.

### Structural Measures

Total structural installation cost is \$1,043,400 and consists of construction, engineering services, project administration, land rights, and relocation payments.

The construction cost of each structural measure is the estimated cost of all material and labor necessary for construction. These costs, estimated to be \$633,400, were determined for each structure and section of channel by estimating the quantities required for construction and applying unit costs based on previously constructed projects. Included in the construction cost is a 12 to 14 percent contingency allowance to cover unforeseen items that may be encountered during construction.

Engineering services are estimated to be \$56,000 and consist of the cost of design surveys, geological investigations, design, and preparation of plans and specifications for the structural measures.

Project administration costs, estimated to be \$108,900, consist of

costs associated with the installation of structural measures, including the cost of contract administration, review of engineering plans prepared by others, government representatives, construction surveys, necessary inspection during construction, relocation assistance advisory services, and the administrative costs associated with making relocation payments.

Project administration costs were not allocated as they were not considered applicable to individual purposes served by the project. The Eighteen Mile Creek Watershed Conservation District will provide relocation assistance advisory services, estimated to be \$400, without PL-566 sharing. The local sponsors and the Service will each bear their respective project administration costs. The local sponsors have requested that the Service administer the contracts for all structural measures.

Relocation payments, estimated to be \$800, consist of the cost of moving and related expenses of the displaced family while their house is being moved and reestablished. Relocation payments costs for the Service and the Eighteen Mile Creek Watershed Conservation District are \$500 and \$300, respectively. (See "Works of Improvement to be Installed" for a detailed description of the relocation required.) The cost-sharing percentages which will be applicable after July 1, 1972, are based upon the ratio of PL-566 funds and other funds to the total project costs, less relocation payments. For those displacements prior to July 1, 1972, the Service will provide the first \$25,000 for each displacement.

Land rights costs include all land values and expenditures made in acquiring easements and rights-of-way, and all costs associated with altering roads, gas and water lines, telephone cables, power lines, or other fixed improvements affected by the structural measures. These total costs are estimated to be \$244,300.

Total joint costs for the installation of Structure 4 amount to \$431,300. These costs were allocated by the use of facilities method. Using this method, 21.5 percent (\$92,700) was allocated to municipal storage and the remaining 78.5 percent (\$338,600) to flood prevention. Specific costs (\$5,500) for grubbing 55 acres in the reservoir to improve initial water quality were allocated entirely to municipal storage.

Estimated installation cost of the flood prevention structures and channel improvement amounts to \$498,100, all of which was allocated to flood prevention.

Following the existing procedure of cost sharing, the total PL-566 cost for structural measures is \$611,800, and other cost amounts to \$322,700 (Table 2A). Adding project administration costs, the PL-566 cost is \$709,700 and other cost is \$333,700 (Table 2).



Schedule of Obligations

Estimated expenditures by years are as follows:

Project Year	PL-566 Funds		Other Funds	
	Structural Measures	Land Treatment	Structural Measures	Land Treatment
First	-	40,000	-	70,000
Second	313,900	37,000	182,200	60,000
Third	174,700	37,000	85,000	60,000
Fourth	140,600	37,000	39,500	60,000
Fifth	80,500	24,400	27,000	40,000
TOTAL	709,700	175,400	333,700	290,000

EFFECTS OF WORKS OF IMPROVEMENT

The project, as proposed, will reduce present annual floodwater damages to agricultural enterprises by 82 percent. This compares favorably with the project objective of 60 percent. The reduction of flooding will permit 600 acres of relatively low producing crops and pastures in the flood plain to be used more intensively. Experimental activities carried on by Clemson University can be accomplished in a more orderly and less expensive manner on 250 acres. The protection afforded will also allow farmers to establish and maintain about 75 additional acres of soybeans, corn and other feed crops and 200 acres of high producing pastures in the flood plain. Most of the remaining acreage in the benefited area is expected to be used for pulpwood and timber production and wildlife habitat.

As a result of the changes that will occur in the flood plain land use, 600 acres of cultivated land in the upland can be converted to grasses, legumes, and trees. Other beneficial land use adjustments include treatment of 650 acres of critically eroding areas.

About 1,950 acres of flood plain below proposed structures will receive flood protection, increasing the income of about 70 farm families. The average annual flooding, including repetitive flooding, will be reduced from about 2,720 acres to 1,350 by the proposed land treatment and structural measures. The acres flooded below proposed structures are shown by storm frequency as follows:

Frequency of Event (Years)	100	10	3	2	1	1/4
Without Project (Acres)	1,950	1,780	1,560	1,380	1,100	160
With Project (Acres)	1,660	1,360	940	810	510	80



Nonagricultural floodwater damages will be reduced about 50 percent. This reduction comes about as a result of lowering the flood stage of damaging storms about one foot in the areas of residential development and reducing the frequency and amount of flood damages to public roads and bridges.

The fish and wildlife resources of the watershed will be substantially enhanced. The development and management of 400 acres for wildlife food and cover on the uplands, other land treatment measures, and treatment of critical areas will improve the wildlife habitat. The impoundment of 225 surface acres of water in the three reservoirs will greatly increase the fishery resource. The reduction of sediment deposits in the channel and a sharp decrease in suspended sediment should improve the fish habitat throughout the watershed.

Sediment deposition and swamping on the flood plain, affecting about 500 acres, will be reduced 81 percent. Sediment delivery to Hartwell Reservoir will be reduced from 48,200 tons per year to 27,200 tons.

It is anticipated that the permanent pools of the three structures will be available to the general public or organized groups for recreational purposes. It is estimated that average annual visitor days for fishing and recreation will total 17,000. Prior to making the pools available, sanitary facilities will be installed in accordance with state health laws. Where sanitary facilities are not provided, recreational use of the pools will be discouraged.

Property values of land adjoining the permanent pools will be enhanced. It is estimated that in the near future, approximately 50 home sites will surround the permanent pools at scattered locations.

Approximately 5,000 people will be directly benefited by the 800 acre feet of water stored in Structure 4. This additional water is expected to accelerate the economic growth of the area as commercial and industrial interests expand. In addition, the 16,000 residents of the watershed will be benefited indirectly by the project.

Construction of the three structures and channel improvement and the establishment of land treatment measures will create additional employment for local residents. Contractors will hire much of their labor locally. Operation and maintenance of structural measures during the life of the project will also help reduce the problems of unemployment and underemployment.

Secondary benefits will accrue from increased business in the area and a generally improved economic situation. Income will be stimulated by an increase in production, transporting, processing, and marketing of goods and services.

### PROJECT BENEFITS

The average annual benefits evaluated for project justification are estimated to be \$125,200 (Table 6). By categories, these benefits are: damage reduction from structural measures, \$54,000; more intensive land use, \$21,500; municipal water storage, \$8,000; incidental, \$19,900; secondary, \$13,700; and redevelopment, \$8,100. The monetary values of fish and wildlife enhancement, reduction in health and safety hazards, aid to mankind from research projects, and beautification of the countryside were not evaluated.

Damage reduction benefits (Table 5) include \$50,700 as a result of reduced floodwater damages. Of this total, \$9,000 is damage reduction to crops and pasture, including \$4,000 restoration benefits. Other agricultural damage reduction benefits in the form of reduced flood damages to farm roads and bridges, equipment, fences and buildings, livestock losses, and Clemson University research activities amount to \$36,000 annually. Nonagricultural floodwater damage reduction benefits total \$5,700 per year, of which about \$3,600 is expected to be benefits to local residences and \$2,100 damage reduction to public roads and bridges and other fixed improvements.

Annual sediment reduction benefits total \$500 from reduced overbank deposition and \$4,900 from swamping. Indirect flood damage benefits are expected to total \$5,500. Land treatment measures account for \$7,600 of the \$61,600 total annual flood damage reduction benefit.

More intensive land use benefits are estimated to be \$21,500 annually.

Benefits from municipal water storage were estimated by consulting engineers representing the town of Liberty to have an annual value of \$8,000.

Incidental benefits will amount to about \$19,900 annually. Of this total, \$14,500 are incidental recreation benefits and \$5,400 are for increased land values for approximately 50 building sites surrounding the permanent pools.

The value of local secondary benefits that will accrue in the watershed and surrounding area due to project installation amount to \$13,700. The value of secondary benefits from a national viewpoint was not considered in the economic evaluation or justification of this project. Redevelopment benefits are estimated to average \$7,800 per year during the life of the project.

Sediment damage reduction benefits to Hartwell Reservoir and the reduction of suspended sediment at the Liberty and Excelsior Finishing

Plant water intakes were not evaluated.

Research and experience have shown that benefits derived from land treatment measures will exceed their cost of installation. Physical effects from proposed land treatment included in this plan were estimated, but no specific determinations of monetary benefits were made for economic justification. Annual benefits accruing as a result of land treatment practices include reduced erosion, lower sediment yields, improved hydrologic conditions, and greater productivity of the soil.

#### COMPARISON OF BENEFITS AND COSTS

The average annual cost of the structural measures, including operation and maintenance, is estimated to be \$58,400. These measures are expected to produce average annual benefits of \$125,200. The ratio of average annual benefits to average annual costs is 2.1 to 1. The benefit-cost ratio without local secondary benefits is 1.9 to 1. A comparison of benefits and costs is shown in Table 6.

#### PROJECT INSTALLATION

##### Land Treatment Measures

The watershed project is planned for a five year installation period. Land treatment measures will be established by landowners cooperating with the local soil and water conservation districts. The soil and water conservation districts, with technical help from the Soil Conservation Service, will assist with the planning and application of these measures. This assistance will be accelerated to assure application of planned measures within the project installation period.

Landowners having forest land will be encouraged to apply and maintain the best forestry measures. The U.S. Forest Service, through the South Carolina State Commission of Forestry, will provide technical assistance for the application of forest land treatment measures. A forester trained in watershed management will be assigned to the watershed to assist the landowners in the installation of the planned forestry measures.

Land treatment measures to be planned and applied in the drainage area of Structure 4, the multiple purpose site, will be directed toward the maintenance of quality water storage for the town of Liberty.

The South Carolina State Commission of Forestry, in cooperation with the U.S. Forest Service, will assist the soil and water conservation district cooperators with tree planting on 365 acres of critical areas. This will be accomplished in accordance with conservation plans developed



with assistance from the local soil and water conservation districts and the Soil Conservation Service. Site preparation and tree planting will be paid for by PL-566 funds. The landowners and operators will buy the trees, furnish mulch material, and construct or relocate fences where needed to protect the seedlings.

The Soil Conservation Service will provide technical assistance for the establishment of grasses and legumes on 285 acres of critical areas. The landowners and operators will prepare the sites and construct or relocate fences where necessary. The required seed, plants, mulch, lime, fertilizer, and fencing materials, as well as cost of planting seed or plants and applying lime and fertilizer will be provided from PL-566 funds.

All critical area plantings will be done through project agreements and district cooperative agreements with the Pickens and Anderson Soil and Water Conservation Districts.

#### Structural Measures

The Eighteen Mile Creek Watershed Conservation District will be responsible for obtaining land rights required for the installation of the structural measures. The town of Liberty will assist in obtaining land rights for Structure 4. The sponsors have the necessary legal authority to acquire needed land rights.

The Service will provide the engineering services for the construction of all channel improvement and structures, except Structure 4. The Service will negotiate an A&E contract with a private engineering firm for the engineering services for Structure 4. The cost of these services for Structure 4 will be shared 21.5 percent by the town of Liberty and 78.5 percent by PL-566.

As a part of project administration, the Eighteen Mile Creek Watershed Conservation District will: (1) provide personally or by first class mail, written notice of displacement and appropriate application forms to the residents displaced, (2) assist in filing applications, (3) review and approve applications for relocation assistance, (4) review and process grievances in connection with displacements and (5) make relocation payments.

As a part of project administration, the Service will assist the Eighteen Mile Creek Watershed Conservation District in fulfilling local relocation responsibilities.

The Eighteen Mile Creek Watershed Conservation District, as a part of project administration, will provide such relocation assistance advisory services as may be needed in connection with the relocation of the displaced persons.



The sponsors have requested that the Service administer the contracts for the construction of structures and channel, and treatment of critical areas. The signing of this Watershed Work Plan Agreement will constitute approval of this request. The town of Liberty will be the sponsor responsible for dealing with the Service during the construction of Structure 4. The Eighteen Mile Creek Watershed Conservation District will deal with the Service during the construction of all other structural measures and the treatment of critical areas.

The structural measures consist of four construction units as shown in Table 7. Each of these units may be constructed as land rights are obtained and funds are available.

Planned installation of structural measures is as follows:

<u>Project Year</u>	<u>Structural Measure</u>
First	None
Second	Structure 4
Third	Structure 3
Fourth	Structure 2
Fifth	Channel Improvement

This schedule may be changed as necessary, except that:

(1) construction on Structure 3 must be concurrently with or after construction of Structure 4; (2) construction of Structure 2 must be concurrently with or after Structures 3 and 4; and (3) channel improvement may not be begun before construction of all structures is assured.

#### FINANCING PROJECT INSTALLATION

Federal assistance for carrying out the planned works of improvement described in the Work Plan will be provided under the authority of the Watershed Protection and Flood Prevention Act (Public Law 566), as amended. This financial and technical assistance to be furnished by the Soil Conservation Service and the U.S. Forest Service is contingent upon appropriation of funds for this purpose. Organizational expenses that will be incurred by the local sponsoring organizations will be provided for in the annual operating budgets of the Pickens and Anderson Soil and Water Conservation Districts, the Eighteen Mile Creek Watershed Conservation District, and the town of Liberty.

Prior to the Service providing financial assistance for the construction of any planned structural measure, the following conditions must be met: (1) the Pickens and Anderson Soil and Water Conservation Districts must obtain agreements to carry out soil and water conservation

plans with necessary conservation measures on not less than 50 percent of the drainage area above each structure, (2) adequate treatment measures must be applied on at least 75 percent of the critical sediment source areas above each structural measure which, if uncontrolled, would materially increase the cost or operation and maintenance of the structural measure, (3) all land rights must be obtained for construction of all structural works of improvement within that construction unit, (4) the Sponsoring Local Organizations must be prepared to discharge their responsibilities, and (5) specific operation and maintenance agreements must have been executed.

The cost of installing land treatment measures which are normally included in conservation plans will be borne by individual landowners. It is expected that the Rural Environmental Assistance Program and other going programs will provide cost-sharing and technical assistance for the installation of some land treatment measures.

Based on a partial survey of landowners within the area of the structural works of improvement, the sponsors expect all land rights to be donated. Necessary funds required for the purchase of land rights not donated, the local share of relocation payments, and relocation assistance advisory services will be obtained from a tax levy on real property within the watershed or from funds provided by the town of Liberty.

Establishment of 650 acres of critical area plantings, except the PL-566 share as indicated under "Project Installation", will be accomplished in accordance with the divisions of works set forth in the Watershed Work Plan Agreement.

Officials of the town of Liberty expect to use existing financial reserves and borrowed funds from private lending agencies or from the Department of Housing and Urban Development to finance the town's portion of the cost of Structure 4.

#### PROVISIONS FOR OPERATION AND MAINTENANCE

Land treatment measures will be maintained by the owners and operators of the land on which they are installed, in cooperation with the Pickens and Anderson Soil and Water Conservation Districts. The South Carolina State Commission of Forestry, in cooperation with the U.S. Forest Service, will furnish the technical assistance necessary for forest land treatment measures under the going Cooperative Forest Management Program. The South Carolina State Commission of Forestry will also continue to furnish fire protection under the going Cooperative Forest Fire Control Program.

Specific maintenance agreements between the Service and the sponsors

will be executed prior to issuing bid invitations for construction of each structural measure. The sponsors will operate and maintain all structural measures. This will include mowing, fertilizing, and controlling the vegetation, replacement of side inlet pipes for the channels, as well as the repair of damage to the emergency spillways, embankments, and stream channels. The Eighteen Mile Creek Watershed Conservation District will be responsible for the operation and maintenance of all structural measures.

The town of Liberty will assist in the operation and maintenance of Structure 4. Funds for this purpose, estimated at \$400 annually, will be obtained through the sale of water and tax revenues.

Clemson University will assist in the maintenance of the improved channel on their property. Funds for this purpose are estimated to be \$1,100 annually.

The Eighteen Mile Creek Watershed Conservation District will operate and maintain Structures 2 and 3. Funds for this operation and maintenance, estimated to cost \$500 annually, will be obtained from the Pickens and Anderson Soil and Water Conservation Districts, or by a tax levy on real property in the watershed.

For three years following installation of each structural measure, the Service and the sponsors will make joint inspections annually, after unusually severe floods or after the occurrence of any other unusual event that might adversely affect the structural measures. Inspection after the third year will be made annually by the sponsors. One copy of their report will be sent to the Service representative and one copy filed by the sponsors and made available for authorized inspection.

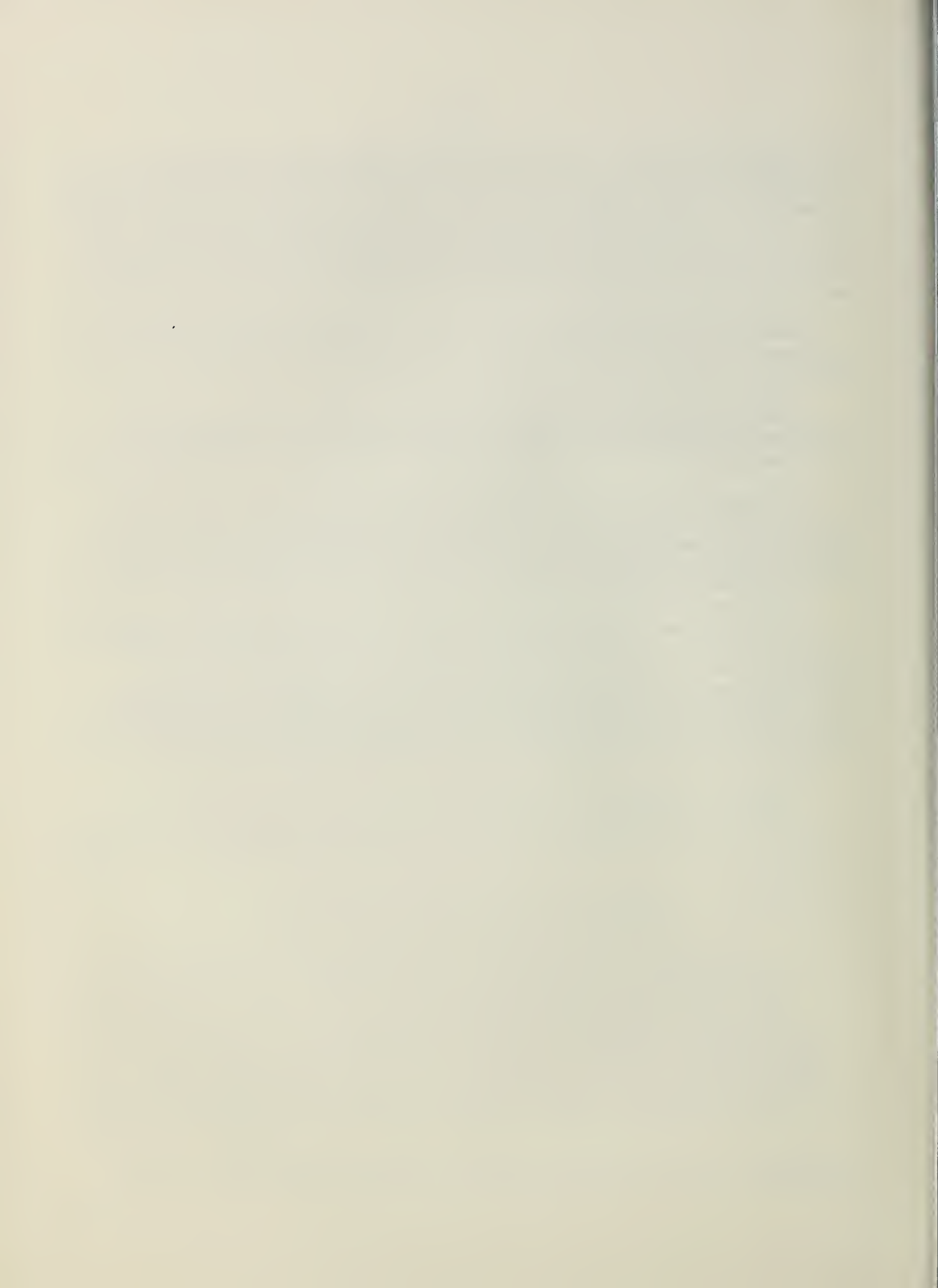




TABLE 1 - ESTIMATED PROJECT INSTALLATION COST

Eighteen Mile Creek Watershed, South Carolina

Installation Cost Item	Unit	Number	Estimated Cost (Dollars) 1/		Total
			PL-566 Funds	Other	
<u>LAND TREATMENT</u>					
Soil Conservation Service					
Cropland	Ac.	600	-	10,700	10,700
Grassland	Ac.	2,000	-	178,200	178,200
Wildlife Land	Ac.	400	-	2,000	2,000
Miscellaneous Land	Ac.	75	-	8,300	8,300
Critical Area Stabilization	Ac.	285	46,500	11,600	58,100
Technical Assistance			75,700	17,000	92,700
SCS Subtotal			122,200	227,800	350,000
Forest Service					
Forest Land	Ac.	4,120	-	45,100	45,100
Critical Area Stabilization	Ac.	365	20,400	5,100	25,500
Cooperative Forest Fire					
Control Program	Ac.	21,300	-	4,300	4,300
Technical Assistance			32,800	7,700	40,500
FS Subtotal			53,200	62,200	115,400
TOTAL LAND TREATMENT			175,400	290,000	465,400
<u>STRUCTURAL MEASURES</u>					
Construction					
Soil Conservation Service					
Multiple Purpose Strs.	No.	1	244,000	72,300	316,300
Floodwater Retarding Strs.	No.	2	249,200	-	249,200
Channel Improvement	L.Ft.	9,850	67,900	-	67,900
Subtotal - Construction			561,100	72,300	633,400
Engineering Services					
Soil Conservation Service			50,200	5,800	56,000
Subtotal - Engineering			50,200	5,800	56,000
Relocation Payments					
Soil Conservation Service			500	300	800
Subtotal - Relocation			500	300	800
Project Administration					
Soil Conservation Service					
Relocation Advisory					
Assistance Services			-	400	400
Construction Inspection			31,600	2,000	33,600
Other			66,300	8,600	74,900
Subtotal - Administration			97,900	11,000	108,900
Other Costs					
Land Rights			-	244,300	244,300
Subtotal - Other			-	244,300	244,300
TOTAL STRUCTURAL MEASURES			709,700	333,700	1,043,400
TOTAL PROJECT			885,100	623,700	1,508,800
<u>SUMMARY</u>					
Subtotal SCS			831,400	560,800	1,392,200
Subtotal FS			53,200	62,200	115,400
TOTAL PROJECT			885,100	623,700	1,508,800

1/ Price base - 1969.

October 1971

TABLE 1A - STATUS OF WATERSHED WORKS OF IMPROVEMENT  
(at time of Work Plan preparation)

Eighteen Mile Creek Watershed, South Carolina

Measures	Unit	Applied To Date	Total Cost (Dollars) 1/
<u>LAND TREATMENT</u>			
Conservation Cropping Systems	Ac.	500	600
Grassed Waterway or Outlet	Ac.	33	2,600
Terrace, Gradient	Ft.	358,000	20,000
Drainage Field Ditch	Ft.	1,000	600
Drainage Main or Lateral	Ft.	6,300	3,500
Tile Drain	Ft.	6,500	4,000
Diversion	Ft.	1,500	200
Pond	No.	18	24,000
Critical Area Plantings	Ac.	1,300	356,500
Pasture & Hayland Management	Ac.	600	13,000
Pasture & Hayland Planting	Ac.	1,000	44,000
Wildlife Habitat Management	Ac.	150	1,000
Access Road	Ft.	2,000	1,600
Tree Planting	Ac.	2,000	40,000
Forest Land Release	Ac.	200	4,000
Cooperative Forest Fire Control	Ac.	21,300	32,000
Other Practices	Ac.	300	7,400
Land Adequately Treated	Ac.	5,700	-
TOTAL	XXX	XXX	555,000

1/ Price base - 1969.

October 1971

TABLE 2 - ESTIMATED STRUCTURAL COST DISTRIBUTION  
Eighteen Mile Creek Watershed, South Carolina

Item	Installation Cost - P.L. 566 Funds (Dollars)				Installation Cost - Other Funds				Total Installation Cost
	Con- struction	Engi- neering	Relocation Payments 2/	Total P.L. 566	Con- struction	Engi- neering	Land Rights	Relocation Payments 2/	Total Other
Multiple Purpose Structure 4	244,000	21,200	-	265,200	66,800	5,800	93,500 3/	-	166,100
Joint Costs	-	-	-	-	5,500	-	-	-	5,500
Specific Costs 4/	244,000	21,200	-	265,200	72,300	5,800	93,500	-	171,600
Subtotal									
Floodwater Retarding Structure 2	110,400	12,000	-	122,400	-	-	39,500 5/	-	39,500
Structure 3	138,800	13,000	500	152,300	-	-	84,300 6/	300	84,600
Subtotal - All Structures	493,200	46,200	500	539,900	72,300	5,800	217,300	300	295,700
Channel Improvement	67,900	4,000	-	71,900	-	-	27,000 7/	-	27,000
Subtotal	561,100	50,200	500	611,800	72,300	5,800	244,300	300	322,700
Project									
Administration				97,900					11,000
GRAND TOTAL				709,700					333,700
									1,043,400

1/ Price base - 1969.

2/ Relocation payments for displacements prior to July 1, 1972, will be shared as provided in PL 91-646 and in paragraph numbered 2 of the Agreement.

3/ Includes \$1,000 for legal fees and \$20,300 for changes to fixed improvements.

4/ Grubbing in reservoir.

5/ Includes \$500 for legal fees and \$21,900 for changes to fixed improvements.

6/ Includes \$1,000 for legal fees and \$44,500 for changes to fixed improvements.

7/ Includes \$2,250 for changes to fixed improvements.

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TABLE 2A - COST ALLOCATION AND COST SHARING SUMMARY

Eighteen Mile Creek Watershed, South Carolina

$\frac{1}{}$   
(Dollars)

Item	COST ALLOCATION			COST SHARING			
	PURPOSE			P.L. 566		OTHER	
	Flood Prevention	Municipal Water	Total	Flood Prevention	Total	Flood Prevention	Total
Multiple Purpose Structure 4	338,600	92,700	431,300	265,200	265,200	73,400	166,100
Joint Costs	-	5,500	5,500	-	-	-	5,500
Specific Costs							
Floodwater Retarding Structures 2 and 3	398,800	-	398,800	274,700	274,700	124,100	124,100
Channel Improvement	98,900	-	98,900	71,900	71,900	27,000	27,000
TOTAL	836,300	98,200	934,500	611,800	611,800	224,500	322,700

$\frac{1}{}$  Price base - 1969.

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TABLE 3 - STRUCTURAL DATA  
STRUCTURES WITH PLANNED STORAGE CAPACITY

Eighteen Mile Creek Watershed, South Carolina

Item	Unit	Structure Number			Total
		2	3	4	
Class of Structure		b	b	b	
Drainage Area	Sq. Mi.	6.23	12.65	7.98	26.86
Controlled	Sq. Mi.	-	7.98	-	
Curve No. (1-day) (AMC II)		72	71	73	
Tc	Hrs.	2.00	4.25	5.81	
Elevation Top of Dam	Ft.	803.0	811.0	885.0	
Elev. Crest Emergency Spillway	Ft.	797.5	806.5	881.5	
Elev. Crest High Stage Inlet	Ft.	776.0	784.0	868.5	
Maximum Height of Dam	Ft.	46	44	42	
Volume of Fill	Cu. Yds.	84,500	41,700	172,500	298,700
Total Capacity	Ac. Ft.	1,775	4,440	3,725	9,900
Sediment Submerged 1st 50 years	Ac. Ft.	151	367	227	745
Sediment Submerged 2nd 50 years	Ac. Ft.	157	433	204	794
Sediment Aerated	Ac. Ft.	41	23	58	122
Municipal Water	Ac. Ft.	-	-	800	800
Retarding	Ac. Ft.	1,426	3,577	2,436	7,439
Surface Area					
Sediment Pool 1/	Acres	28	67	64	159
Municipal Pool	Acres	-	-	130	130
Retarding Pool	Acres	143	321	263	727
Principal Spillway					
Rainfall Volume (areal) (1 day)	In.	8.0	8.5	8.8	
Rainfall Volume (areal) (10 day)	In.	14.0	15.3	15.5	
Runoff Volume (10 day)	In.	7.26	8.17	8.91	
Capacity of High Stage (Max.)	cfs	178	444	180	
Frequency of Operation - Emer. Spillway	% Chance	2	1	1	
Size of Conduit	Inches	36	54	36	
Emergency Spillway					
Rainfall Volume (ESH) (areal)	In.	9.0	9.5	9.5	
Runoff Volume (ESH)	In.	5.58	5.90	6.16	
Type	veg.	veg.	veg.	veg.	
Bottom Width	Ft.	170	332	260	
Velocity of Flow ( $V_e$ )	Ft./Sec.	5.1	3.3	2.2	
Slope of Exit Channel	Ft./Ft.	0.03	0.03	0.03	
Max. Water Surface Elev.	Ft.	799.2	807.1	881.7	
Freeboard					
Rainfall Volume (FH) (areal)	In.	15.0	15.9	15.9	
Runoff Volume (FH)	In.	11.17	11.87	12.19	
Max. Water Surface Elev.	Ft.	803.0	811.0	885.0	
Capacity Equivalents					
Sediment Volume	In.	1.05	1.22	1.15	
Retarding Volume	In.	4.29	5.30	5.72	
Water Supply Volume	In.	-	-	1.88	

1/ 50 year, except Structure 4 which is 100 years.

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TABLE 3A - STRUCTURAL DATA  
CHANNELS

Eighteen Mile Creek Watershed, South Carolina

Channel	Station Numbering For Reach	Drainage Area (sq. mi.)	Capacity (cfs)		Hydraulic Gradient (ft/ft)	Channel Dimensions		"n" Value Aged	Velocities 2/ As		Excavation (cu. yds.)
			Req'd 1/	Design		Bottom (ft.)	Depth of Flow (ft.)		Aged (fps)	Built (fps)	
Eighteen Mile Creek	748+50	49.43	2,800	2,844	0.00170	62	6.5	0.030	6.4	7.7	37,000
	785+50	51.95	3,000	3,000	0.00129	75	6.5	0.030	5.7	6.8	59,600
	832+00	52.05	3,042	1,325	0.00060	75	5.5	0.035	3.0	4.2	13,300
	844+00				Transition to Existing Channel						1,200
	847+00										

1/ Peak discharge for two year frequency, 24 hour duration storm.

2/ Side slopes = 1:1 n = 0.025 for as built channels.

Type of improvement is channel enlargement.

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TABLE 4 - ANNUAL COST

Eighteen Mile Creek Watershed, South Carolina

<sup>1/</sup>  
(Dollars)

Evaluation Unit	Amortization of Installation Cost <sup>2/</sup>	Operation and Maintenance Cost <sup>3/</sup>	Total
Floodwater Retarding Structures 2 and 3, Multiple Purpose Structure 4, and Stream Channel Improvement	50,500	2,000	52,500
Project Administration	5,900		5,900
TOTAL	56,400	2,000	58,400

<sup>1/</sup> Price base: Installation Cost - 1969 prices, O&M - Adjusted Normalized prices.

<sup>2/</sup> Amortized at 5 3/8 percent interest rate for 100 years.

<sup>3/</sup> Includes \$150 for replacement of side inlets.

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TABLE 5 - ESTIMATED AVERAGE ANNUAL FLOOD DAMAGE REDUCTION BENEFITS

Eighteen Mile Creek Watershed, South Carolina

Item	Estimated Average Annual Damage <sup>1/</sup> (Dollars)		Damage Reduction Benefit
	Without Project	With Project	
Floodwater			
Crop and Pasture	12,500	3,500	9,000
Other Agricultural	42,200	6,200	36,000
Nonagricultural	11,500	5,800	5,700
Subtotal	66,200	15,500	50,700
Sediment			
Overbank deposition	900	400	500
Swamping	5,800	900	4,900
Subtotal	6,700	1,300	5,400
Indirect	7,000	1,500	5,500
TOTAL	79,900	18,300	61,600

<sup>1/</sup> Price base - Adjusted Normalized.

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TABLE 6 - COMPARISON OF BENEFITS AND COSTS FOR STRUCTURAL MEASURES

Eighteen Mile Creek Watershed, South Carolina

Evaluation Unit	(Dollars)						Average Annual Cost 2/	Benefit Cost Ratio
	Damage Reduction	More Intensive Land Use	Municipal Water	Incidental	Secondary	Redevelopment	Total	
Floodwater Retarding Structures 2 and 3, Multiple Purpose Structure 4, and Stream Channel Improvement	3/ 54,000	21,500	8,000	4/ 19,900	13,700	8,100	125,200	52,500
								2.4 to 1
Project Administration								
GRAND TOTAL	54,000	21,500	8,000	19,900	13,700	8,100	125,200	5,900
								58,400
								2.1 to 1

1/ Price base: Adjusted Normalized.

2/ From Table 4.

3/ In addition, it is estimated that land treatment measures will provide flood damage reduction benefits of \$7,600 annually.

4/ Includes \$14,500 incidental recreation benefits and \$5,400 for increased land values adjacent to permanent pools.

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TABLE 7 - CONSTRUCTION UNITS

Eighteen Mile Creek Watershed, South Carolina

(Dollars)<sup>1/</sup>

Measures in Construction Unit	Annual Benefit	Annual Cost
1. Structure 4	33,600	26,000
2. Structures 3 and 4	49,700	39,600
3. Structures 2, 3, and 4	64,700	49,100
4. Structures 2, 3, and 4 and Channel Improvement	124,700	55,800

1/ Price base: Benefits - Adjusted Normalized  
Installation Cost - 1969.

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## INVESTIGATIONS AND ANALYSES

### Land Use and Treatment

Present land use was determined from soil and water conservation district reports, surveys, and field studies. Estimates of future land use and treatment measures were made on the basis of the people involved, the land within the watershed and present trends in the community. Needed land use adjustments based on land capabilities were considered in arriving at the land treatment measures planned for the watershed.

The costs of installing the land treatment measures were developed by the Soil Conservation Service, the South Carolina State Commission of Forestry, and the U.S. Forest Service. Technical assistance costs were based on the present costs of the going soil and water conservation district program and going Cooperative Forest Management Program. Costs of installing land treatment measures were based on present prices paid by landowners and operators in the locality. The amount of private forest land treatment measures needed to meet treatment goals was based on a field survey of the watershed adjusted for expected participation during the installation period. The estimates for the amount of all other land treatment measures were developed by the Soil Conservation Service.

### Structures

Vertical control for the structural measures is based upon mean sea level datum as established by U.S. Coast and Geodetic Survey and U.S. Geological Survey. Temporary bench marks were established throughout the watershed.

Topographic maps with five foot contour intervals were made of the reservoir area of each floodwater retarding structure. These maps were made using low level aerial photography and the stereoplotter. The maps were used to develop stage-area and stage-storage curves and are adequate for final design.

Floodwater retarding structures were designed in accordance with SCS Engineering Memorandum 27. Flood storage for each structure was determined, using the computer by flood routing the 10-day hydrograph for the principal spillway design storm. Discharge rates were held to near the minimum that would empty the pool within 10 days. The emergency and freeboard hydrographs were also routed using the computer. The principal spillways and the emergency spillways were proportioned to determine the most economical structures.

The Harwood Beebe Company, of Spartanburg, S.C., consultants for the town of Liberty, determined the quality and quantity of municipal

water storage and provided the necessary data for the proposed multiple purpose structure.

During the preliminary site investigation of Site 4, the multiple purpose site, a compressible material with some organic material was found in the investigation in the flood plain. A detailed investigation may determine that this material will have to be removed. The cost of the removal of this material was included in the construction cost estimate.

### Channels

The existing channel banks are nearly vertical and the channel is stable. The existing channel does not contain the one year frequency, 24 hour storm without flooding and will barely contain the maximum principal spillway discharges from the proposed upstream floodwater retarding structures.

The channel improvement is designed to provide protection from the two year frequency, 24 hour duration storm. The design grade and depth of channels are approximately the same as the existing depth and grade, except in the lower reach where the channel is steeper than the existing grade.

Channels were designed using Manning's formula and water surface profile data. The "n" values used for the channel design were based on the recommendations contained in the National Engineering Handbook, Section 16, Chapter 6. These values were reduced to 0.025 to determine velocities for newly constructed channels. The design discharge shown in Table 3A is the discharge which the channel will contain before flooding begins for the aged "n" value.

Horizontal distances for channel design were established from a semi-controlled watershed map. Representative cross sections, based upon mean sea level, were used to establish the point where damage begins and to show existing channel features.

Representative samples of materials from the channel banks were collected and tested in the South Carolina Highway Department's Soil Laboratory. These materials were classified as SM, ML, and CL with the plasticity indices ranging from non-plastic to 10. A test of the proposed channel design was made with a bed-load transport equation. This test indicated degradation in the channel down to Station 825+00 and aggradation below this. Three temporary rock riprap chutes are planned to control the grade and degradation of the channel upstream from Station 825+00 while vegetation is being established.

Channel stability was determined from a study of the existing and proposed channel and from a recent study of approximately 100 miles of



channel enlargement existing in eight watersheds in the Piedmont area of South Carolina. Some of the variables considered were drainage area, discharge, gradient, velocity, soil classification and plasticity, vegetative cover, and rock ledges. The designed dimensions of the improved channels were compared with the present dimensions. These improved channels are stable and good vegetative cover was normally established during one growing season.

Information obtained from this study and the study of the existing channel was used to plan the channel improvement for this watershed. The planned channel improvement compares favorably with other watersheds in this area of the Piedmont which are stable and well vegetated. The soil materials of the Eighteen Mile Creek channels are similar to the soil materials of the Broadmouth Creek Watershed channel; however, the Eighteen Mile Creek channel has milder slopes, lower aged "n" values, and is wider than the Broadmouth Creek channel. All planned channel improvement in this project will be stable with a minimum amount of erosion.

#### Forestry

A systematic field survey identified ground cover, forest and hydrologic conditions and treatment needs. The survey, supporting data, and information from other agencies and forestry officials determined the amount of remedial measures. The effects of the proposed works of improvement on forest fire hazard and risk were analyzed. The measures recommended contribute to flood reduction and soil stabilization.

#### Fish and Wildlife

Representatives of the South Carolina Wildlife Resources Department and the U.S. Bureau of Sport Fisheries and Wildlife determined that the project would not adversely affect fish and wildlife in the watershed. Fish and wildlife resources in the watershed are of low value. The permanent pools of the reservoir will provide an increase in fishing opportunities, while land treatment practices will enhance the wildlife habitat.

#### Hydraulic and Hydrology

An analysis of the watershed was made using procedures in the National Engineering Handbook, Section 4, Part 1, Watershed Planning. This analysis was used to develop physical data for the economic evaluation and design of proposed works of improvement.

The partial duration series of rainfall was developed using rainfall data from the U.S. Weather Bureau Technical Paper No. 40, "Rainfall Frequency Atlas of the United States".



The weighted average runoff curve numbers for the watershed and structures were determined by applying information obtained from local observation, the U.S. Forest Service, District Conservationists, and Soil Scientist to the procedures outlined in the National Engineering Handbook, Section 4, Part 1, Watershed Planning. Runoff was determined by applying rainfall amounts to the weighted average curve number.

The principal spillway, emergency spillway, and freeboard hydrographs were developed in accordance with Chapter 21 of the National Engineering Handbook, Section 4, Part 1, Watershed Planning.

Water surface profile computations, using the I.B.M. 1130 Computer, were used to determine stage-discharge relationships for representative cross sections. Stage-area flooded data, by depth increments, for these cross sections were also calculated by the computer.

The 1, 10, 33, 50, 100, and 400 percent chance storms were routed through representative cross sections using the Convex method of routing by the I.B.M. 1130 Computer.

Reservoir operation studies were made on Structure 4. These studies were accomplished by use of the 1130 Computer and the following data:

1. Area-storage curves were developed for the structure.
2. The most critical drought period on record (calendar years 1952 through 1956) was selected for the study.
3. The U.S. Geological Survey stream gage records on Reedy River near Greenville, South Carolina, were used to obtain monthly inflow in inches.
4. The following records were used to compute the net evaporation from the reservoir surface:
  - a. U.S. Weather Bureau Class A pan records at Clemson, S.C.
  - b. U.S. Weather Bureau standard rain gage at Clemson, S.C.
5. A seepage rate of 0.1 feet per month was used.

The engineering firm representing the town of Liberty made a reservoir operation study at Site 4 location. Their report states that 750 acre feet of beneficial storage at this site will yield four million gallons of water per day 19 of every 20 years. This yield is adequate to meet the town's future needs as projected by the engineering firm and the town of Liberty.

The planned beneficial storage in Site 4 is 800 acre feet. Reservoir operations studies made by Soil Conservation Service personnel confirm those made by the engineering firm.

### Economics

Methods used in making the economic investigations and analyses were those suggested by the Soil Conservation Service in benefit-cost evaluation of land and water resource projects. Basic data were obtained from local landowners, farmers, agricultural workers, experiment stations, university and USDA publications, town, county and Clemson University officials, state highway department personnel, private engineers, and local real estate developers.

Adjusted normalized prices were derived from data approved by the Interdepartmental Staff Committee, Water Resources Council, April 20, 1966. These prices were used in all benefit computations and operation and maintenance costs. Present (1969) prices were used in computing installation costs. The costs of all structural measures were amortized over a 100-year period, using 5 3/8 percent interest rate.

Owners and operators of flood plain land were interviewed to determine present land use and estimated yields with various degrees of protection from flooding. These data were summarized for 11 evaluation reaches covering all of the protected area below structural measures. Damage values were derived from these summaries and from cost-price information. Yields used in the analysis are those that would normally be expected in the future without and with the project.

Road and bridge damage estimates were obtained from state and county highway officials and from observations of other local authorities.

Reduction of overbank deposition, restoration of former productivity or more intensive land use benefits were claimed on portions of 1,780 acres, the area flooded by the 10 year, 24 hour frequency storm. Caution was taken not to double count or duplicate benefits claimed. Sediment damage reduction benefits were estimated on the basis of increased net income which is expected to accrue as a result of recovery of land damage. Consideration was given to the amount of damage, degree of recovery, and the recovery period.

Restoration of former productivity and more intensive land use benefits were claimed in those areas where flood protection provided by the project will adequately justify increased expenditures by landowners and, where by virtue of current ownership and interest, there will likely be efforts exerted toward more intensive use of this highly productive land. No benefits were claimed on about 600 acres of flood plain where future land use is expected to be mostly pulpwood and timber production or wildlife habitat areas. These areas will generally have a lower level



of protection than most of the remaining flood plain, but will benefit to some degree from damage reduction to roads, trails, fixed improvements, fish and wildlife habitat, reduced woodland harvesting costs, and a more orderly marketing schedule. The soils of the flood plain are mostly Classes IIw, IIIw, and IVw. The planned land use is within the capability of these soils.

Associated costs and increased damages because of greater damageable values have been considered in deriving restoration and more intensive land use benefits.

Municipal water benefits were estimated by consulting engineers, representing the town of Liberty. These benefits were checked for reasonableness and to determine if they exceeded cost, in accordance with Chapter 8 of the Economics Guide and Paragraph 109.07 of the Watershed Protection Handbook.

Benefits from incidental recreational use have been claimed for all structures. The sites are within easy driving distance of several metropolitan areas. Benefits valued at \$1.00 per visitor day were estimated to accrue at the rate of 75 visitor days per surface acre per year for all sites. Non-project associated costs to allow for construction and maintenance of proper sanitation measures, access roads, liability insurance, and other necessary recreational facilities were deducted. These costs are expected to amount to \$1,600 annually. After allowing for associated costs and discounting for sediment accumulation, incidental recreation benefits will amount to \$14,500 annually. Benefits were evaluated on the 50-year sediment pool with full level benefits for the first 40 years and on a declining basis for the remaining 10 years for Structures 2 and 3. Benefits accruing at multiple purpose Site 4 were not discounted.

Enhanced property values that will come about as a result of the project were derived by comparing the present value of building sites with utilities in the immediate vicinity with the estimated worth of the same properties with a water-front boundary. A net increase of \$2,000 each for 50 lots amounted to \$100,000. This was amortized, using  $5 \frac{3}{8}$  percent for 100 years, to arrive at average annual benefits from enhanced land values. The development of these properties is only a small portion of the total land adjacent to the permanent pools and, therefore, is not expected to interfere with access by the general public or organized groups.

Indirect damages were estimated to be 10 percent of direct flood-water and sediment damages to land, crops and pastures, home sites, roads and bridges, and other fixed improvements.

Local secondary benefits were estimated in accordance with Paragraph 102.02213 of the Watershed Protection Handbook and Chapter 11 of the



Economics Guide. The value of local secondary benefits stemming from and induced by the project was estimated to be 10 percent of (1) direct primary project benefits, (2) increased production costs that producers will incur in connection with higher production levels and intensified land use, and (3) associated costs in achieving project benefits.

Secondary benefits from a national viewpoint were not considered in the evaluation of the project.

Redevelopment benefits were estimated in accordance with Appalachian Memorandum-2, Chapter 12 of the Economics Guide, and Paragraph 102.02212 of the Watershed Protection Handbook. Wage payments to local labor during construction were estimated to be 30 percent of the construction costs. This value was amortized at  $5 \frac{3}{8}$  percent interest for 100 years to arrive at annual redevelopment benefits from this source. Fifty percent of the annual operation and maintenance cost was used as the value of annual wages paid to local labor. This value was treated as a decreasing annuity for 25 years at  $5 \frac{3}{8}$  percent interest and converted to an annual equivalent over the project life.

### Sedimentation

Estimates of sediment storage needed were made in accordance with procedures outlined in Technical Release No. 12, "Procedures for Computing Sediment Required for Retarding Reservoirs", U.S. Department of Agriculture, Soil Conservation Service, January 1968. Primary sources contributing to downstream damages in the watershed are small but numerous critical areas. The acreage and location of critical areas as identified in the field can be found on blue-line maps in the Watershed Planning and District Conservationists' files.

Estimated sediment storage volumes were based on a unit weight of 65 pounds per cubic foot for submerged sediment and 85 pounds per cubic foot for aerated sediment. The submerged unit weight was based on reservoir sedimentation surveys of similar areas. The aerated unit weight was based on dry unit weights determined from upland samples. The variation in estimates of sediment allocation to the three flood storage areas is 5 to 25 percent. These estimates were based on texture of sediment, shape and size of reservoirs, ratio of permanent pools to temporary pools, and entry slopes.

Estimates of suspended sediment concentration for two water intakes on Eighteen Mile Creek were made following procedures outlined in Chapter VIIA of the "Guide to Sedimentation Investigations", prepared by the E&WP Unit of the South Regional Technical Service Center, revised July 1968. The present estimated suspended sediment concentration at the Liberty water intake is 815 p.p.m., and 285 p.p.m., at the Excelsior finishing plant intake. At present an estimated 48,200 tons of sediment are annually entering the backwaters of Hartwell Reservoir.

Approximately 86 percent of this sediment is in the suspended state.

A test of the proposed channel design was made with a bed-load transport equation for a three year frequency storm. Degradation is expected in the channel reach from County Road 56 to one-half mile below County Road 279. Aggradation is anticipated for the remaining improved channel.

A study of physical damages to the flood plains of the watershed was made for major damage reaches. A representative cross section was selected for each damage reach. Sediment damages were based on surface inspection and hand auger borings along the selected cross section. Damages were summarized by evaluation reaches and adjusted for recoverability of productive capacity. Estimates of recoverability were developed from field studies and interviews with farmers. Calculations of reduction in sediment yield by evaluation reaches were made to determine reduction due to structural and land treatment measures. Reduction in damage for channel improvement was based on total floodwater reduction computations.

Three periods of sedimentation have been interpreted from the borings made along the cross sections. These chronological periods are: (1) recent, (2) modern, and (3) present. All three periods are represented in the borings. Except for the lower end of the watershed, recent sediments were deposited in a reducing environment. Modern sediments generally comprise 3 feet of a 4 foot hole. The modern profile indicates rapid deposition of fertile topsoils (generally 6 inches) overlain by rapidly deposited subsoils (oxidized). With the exception of the lower reaches where frequent flooding continues to leave silt-clay sized deposits, present sediment deposits are not severe.

#### Damsite Investigations

Detailed field studies were made in the watershed after reviewing existing geologic reports and maps. Preliminary investigations of structure sites were made. Hand auger borings were made on all sites. The watershed conforms to the NE-SW trending Pendleton syncline. The most frequently encountered rock type in the watershed is granitic gneiss. This rock appears to be an intrusion into the country rocks of the Pendleton syncline. The principal country rocks are biotite and hornblende gneiss.

Preliminary and hand auger investigations of Site 4 indicated a need for further foundation investigations. A low head dam one-quarter mile downstream has contributed to swamping at the proposed site location. A preliminary boring taken through ice revealed a highly compressible MH material. An earthen ramp was constructed 250 feet onto the flood plain to facilitate further investigations. Three borings taken through the ramp with a Failing CFD-2 power auger revealed two principal zones, a

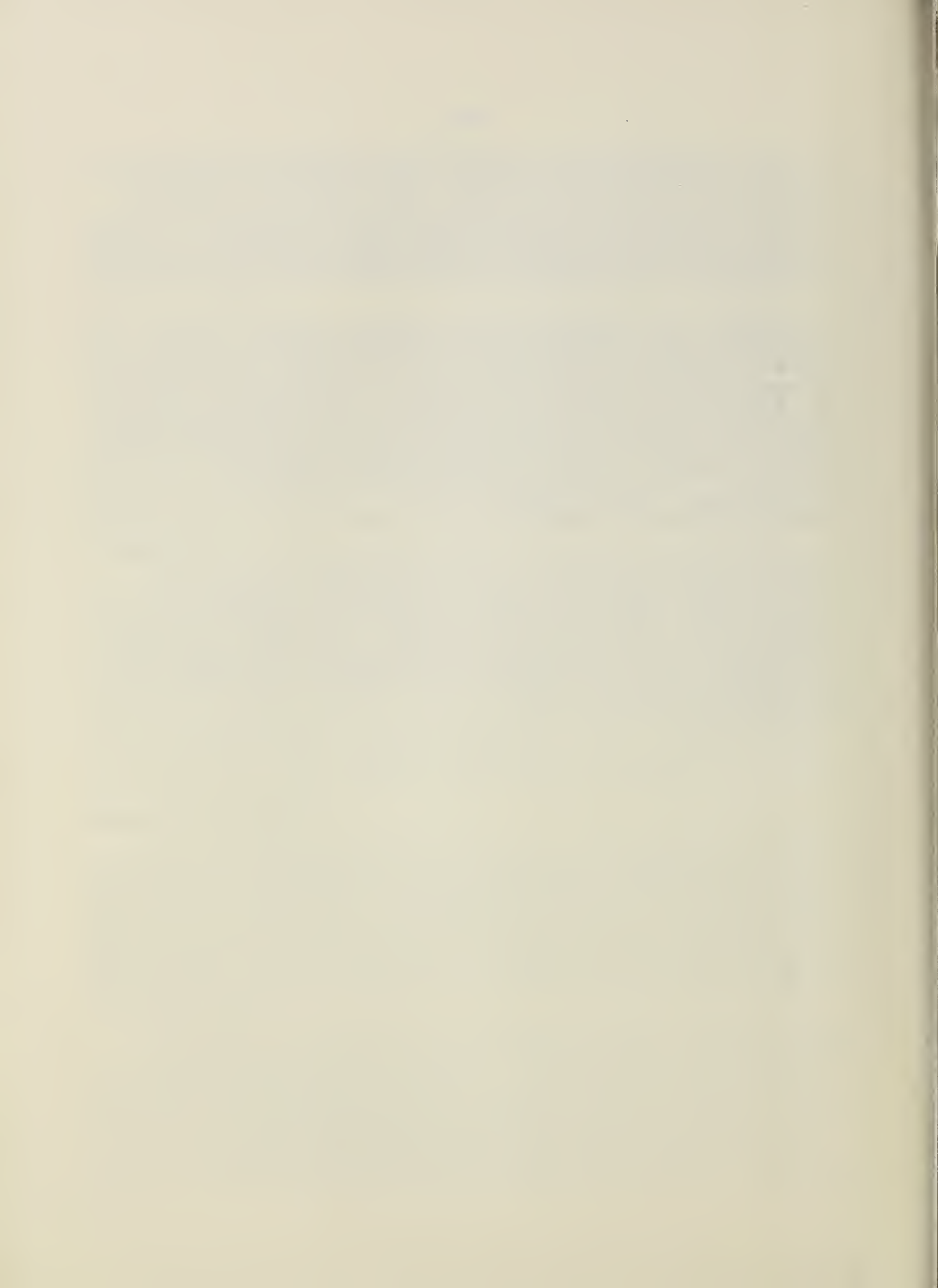
MH, ML material approximately five feet deep underlain by SM, SP, SC materials to depths of 10 to 18 feet. Parent material SC, SM, ML was encountered at depths of 10 to 18 feet. The investigations indicated that satisfactory foundation conditions can be had by pre-draining the foundation with V-ditches and by removing the MH, ML material. A seepage analysis was made using Darcy's equation. Permeabilities were estimated. The seepage loss was calculated to be 0.0028 feet per month.

Borings in the emergency spillway of Site 3 were made with a Failing CFD-2 power auger to determine if a rock spillway could be attained. No rock was encountered in the borings. Ample borrow of suitable quality for construction was found below the top of dam elevation and within 300 to 1,300 feet of the dams at Sites 2 and 4. It was determined that all of the borrow for Site 3 could be obtained from the proposed emergency spillway cut. There are no noticeable characteristics considered detrimental to the construction of the three proposed structures.

#### Channel Stability Investigations

Preliminary investigations of the proposed channel work indicated fairly uniform bank materials. The present channel in the area of proposed channel improvement is stable. Channel enlargement has previously been done in this reach. However, hand auger holes in the adjoining flood plain indicate that in places the proposed channel will be in different materials from those exposed in the bank. Samples representative of the present banks were analyzed. These bank samples were classified as SM, ML, CL.

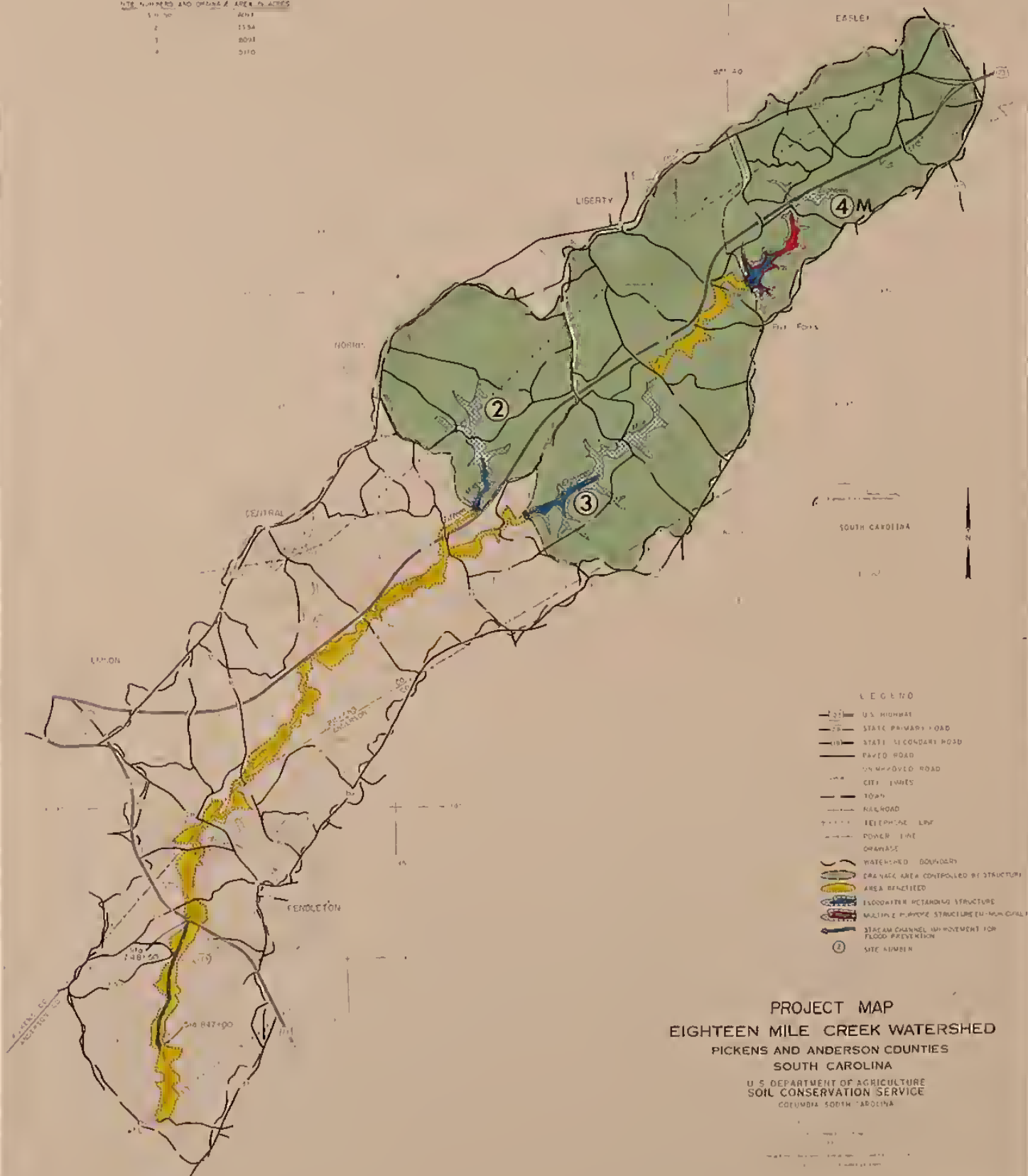






WATER NUMBER AND ORIGIN & AREA IN ACRES

WATER NO.	ACRES
2	1134
3	8091
4	3110



PROJECT MAP  
EIGHTEEN MILE CREEK WATERSHED  
PICKENS AND ANDERSON COUNTIES  
SOUTH CAROLINA

U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE  
COLUMBIA, SOUTH CAROLINA





